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METEORITES

FOUND IN

PENNSYLVANIA

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METEORITES FOUND IN PENNSYLVANIA

By Ralph W. Stone

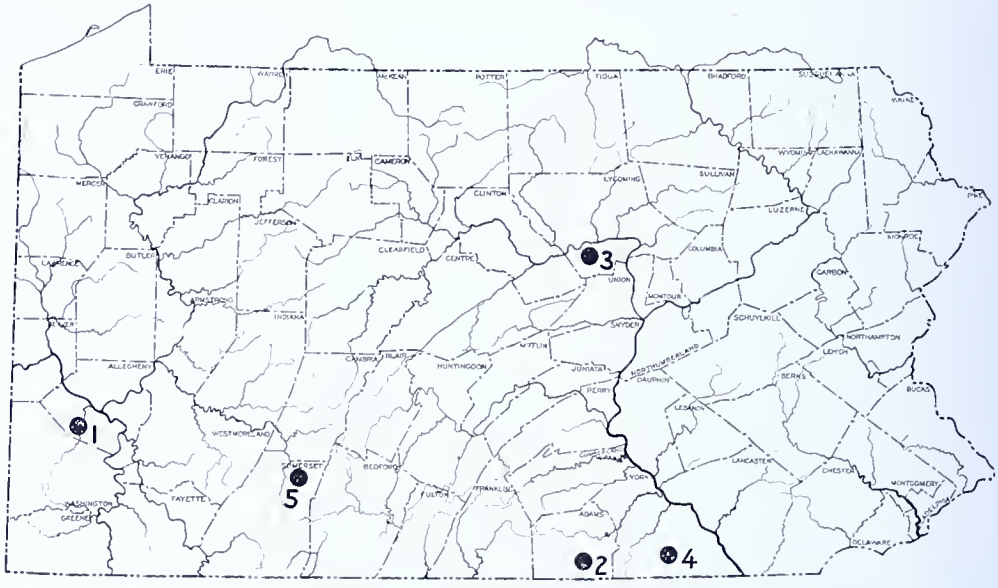
INTRODUCTION

A meteorite is defined in the Century dictionary as a mineral or metallic mass of extraterrestrial origin, or which, to use the common expression, has "fallen from the heavens." A meteor, on the other hand, is "a transient fiery or luminous body seen in or through the atmosphere, usually in its more elevated region; a shooting-star." While in the sky it is a meteor, but when it reaches the surface of the earth, it becomes a meteorite.

Most dwellers in the country have seen meteors flash across the sky at night and know, perhaps, that shooting stars are most numerous in the fall of the year. A multitude of small bodies is always flying through space in different directions and at different rates. Some of them revolve around the sun as if they were planets, but others do not belong to our solar system. The shooting stars so commonly seen in the evening sky in August, September, and November are small bodies which diverge from the swarms of meteors that pursue fixed paths around the sun. These falling bodies are made luminous by friction with our atmosphere and most of them disappear in the sky by being consumed or burnt out. Many meteors are too small to be seen and of course those passing through the air in daylight are invisible. The number of meteors which enter our atmosphere daily has been estimated at 15,000,000 to 20,000,000. If on the average these meteors weigh ten grains each, which may be a high estimate, the total quantity of such matter reaching the earth annually from the outer space would be 5,000 to 7,000 tons. As something like three-fourths of this matter must fall in the sea, the quantity showered on the land is so small as to be wholly unnoticed. In fact at the rate suggested it would take something like four billion years to cover the sea bottom with a layer one inch thick.

Occasionally a meteorite has been seen or heard to strike the earth and has been found on or under the freshly disturbed surface. These bodies of known celestial origin have led to the identification of similar bodies found in the earth as also from the sky. Meteorites, almost without exception, have a definite family resemblance, which suggests that all came from one celestial body, or if they came from different bodies, or from another solar system, the sources are much alike and not unlike the earth itself. Over 820 meteorites or meteoric falls have been found, identified as such, and recorded; this for the whole world. Over 200 meteorites are credited to the United States. The Field Museum

of Natural History in Chicago has 670, the American Museum of Natural History in New York contains representatives of over 400 falls, and the U. S. National Museum about 350 falls. Several museums may have slices or fragments from the same meteorite, for mineralogists customarily share in such a find by cutting it. From these collections it has been learned that some meteorites consist almost wholly of metal, chiefly iron alloyed with a small per cent of nickel; some consist of metal and rock intimately mixed; and some are just plain rock. Also it is apparent that they are of igneous origin, they contain no elements not known on the earth, and they bear no evidence that there is life or water where they came from. The stony meteorites are never granitic in character



1. Map of Pennsylvania showing where meteorites were found.

1. Pittsburgh, 1850; 2. Mount Joy, Adams County, 1887; 3. Bald Eagle, Lycoming County, 1891; 4. Shrewsbury, York County, 1907; 5. New Baltimore, Somerset County, 1922.

but resemble certain volcanic rocks. The metallic meteorites are predominatingly iron, and almost invariably contain several per cent of nickel, with lesser quantities of cobalt, copper, tin, sulphur, and phosphorus. The precious metals have not been detected in them.

Five meteorites have been found in Pennsylvania and, curiously, all of them are solid iron. The first one was discovered near Pittsburgh in 1850 and the others at the following places: Mount Joy Township, near Gettysburg, Adams County, 1887; Bald Eagle Mountain, near Williamsport, 1891; Shrewsbury, York County, 1907; and New Baltimore, Somerset County, 1922.

Three of these meteorites were found by farmers while plowing, one by a man digging a hole to plant a tree, and one by laborers gathering rock for a stone crusher. The smallest, that found on Bald Eagle Mountain near Williamsport, was about the size and shape of an adult human foot and weighed 7 pounds. The Shrewsbury iron weighed 24 pounds, the New Baltimore about 40, and the

Mt. Joy, the third largest found in the United States and the largest east of Mississippi River, weighed 847 pounds. The weight of the Pittsburgh meteorite found in 1850 is not known because it was wrought into a bar and lost. It is reported as 292 pounds, but this does not agree with the statement that it was oval in shape and 6 or 7 inches in diameter.

The present location of these celestial visitors is as follows:

Bald Eagle. In museum of Bucknell University, Lewisburg, Pa.

Mount Joy. Main mass is in Vienna Museum. National Museum, Washington, D. C., has a full-sized cast of the original, and several pieces, and the Academy of Natural Sciences, Philadelphia has an etched slice. The Mineralogical Museum at Harvard University has a piece weighing 568 grains, and Mineralogische-Geologische Stattinstitut, Hamburg, Germany, has a piece weighing 248 grains.

New Baltimore. A small fragment and model of the whole are in the State Museum, Harrisburg, Pa. A small fragment with a polished etched surface is in the Academy of Natural Sciences, Philadelphia, the National Museum at Washington has a slice, and the main mass is in the Mineralogical Museum at Harvard University, Cambridge, Mass.

Pittsburgh. Small fragment in museum of Yale University, New Haven, Conn.

Shrewsbury. Sliced into museum specimens and widely distributed among collections in this country and abroad. Slice from it in National Museum, Washington, D. C., and at Academy of Natural Sciences, Philadelphia.

Not infrequently nodules of pyrite and marcasite, sulphides of iron, are mistaken for meteorites. They are heavy and of peculiar appearance but can be readily distinguished from iron meteorites, however, by their crystalline faces and brass yellow color on fresh fracture.

CHEMICAL COMPOSITION

Chemical composition of Pennsylvania meteorites

	Bald Eagle	Mt. Joy	New Balto.	Pitts-burgh	Pitts-burgh	Shrews-bury
Iron	91.36	93.80	93.256	92.809	93.38	90.84
Nickel	7.56	4.81	6.420	4.665	5.89	8.80
Cobalt	0.70	0.51	0.325	0.395	1.24	trace
Copper	.....	0.005	none	0.034	0.05	.....
Sulphur	0.06	0.01	none	0.037	0.07	0.01
Phosphorus	0.09	0.19	0.037	0.251	0.15	0.29
Manganese	.....	.....	none	0.141	0.00	.....
Silicon	trace	.....	0.010	.....	.....	.....
Carbon	.....	.....	0.015	.....	.....	.....
Chromium	.....	.....	.....	.....	0.02	.....
Chromite	.....	.....	.....	.....	0.07	.....
	99.77	99.325	100.63	98.332	100.87	99.94

The preponderance of iron, about 92 to 94 per cent, the notable quantity of nickel, and the insignificant traces of other metals and minerals are clearly shown in this table.

The almost identical composition of the Mt. Joy, New Baltimore, and Pittsburgh meteorites and the fact that the three localities are practically in a straight line suggest that these may be parts from a larger body which was disrupted as it passed through the earth's atmosphere. The fact that the New Baltimore locality is 10 miles south of a line from the locality near Gettysburg to the site south of Pittsburgh and that these places are 150 miles apart does not seem incompatible with the idea of a single source when it is known that the average velocity of meteors passing through our atmosphere is computed to be between 20 and 30 miles a second and the height of passage above the earth may be several miles. Furthermore, as none of these was seen to fall, and the last was discovered 72 years after the first, all may have been buried in the soil for a hundred years or more.

ORIGINAL DESCRIPTIONS

A search for information about Pennsylvania's meteorites has disclosed no one source for all the data. Farrington's catalogue[1] of North American meteorites published in 1913 contains references to the first three. The original descriptions are in various periodicals, complete files of which are to be found only rarely. For the convenience of those who are interested in further details than the bare facts given above, the leading papers are reprinted here, in alphabetic order rather than by date of discovery.

Mineral terms used in these descriptions are defined as follows:

Daubreelite. Native chromium sesquisulphid, a rare mineral known to occur only in certain meteoric irons. It has a black color, metallic luster, and is associated with troilite.

Kamacite, one of the names given to various peculiar forms observed in meteoric iron, being tin-white blades or grains of iron carrying a small percentage of nickel.

Neumann's lines. A series of fine lines representing structure, developed in some meteoric irons.

Schreibersite. A phosphide of iron and nickel, occurring in steel-gray folia and grains in many meteoric irons: it is known to occur as a terrestrial mineral.

Plessite. A nickeliferous iron with less obvious indications of structure and generally darker color than the other irons found only in meteorites.

Taenite. A nickeliferous iron found in meteorites and commonly occurring in narrow, bronze-yellow blades.

Troilite. A native iron sulphid often occurring in meteorites, and especially meteoric irons, as embedded nodules or generally disseminated. It is granular, bronze-yellow, and has a dull luster.

Widtmannstattian figures. Peculiar markings seen on the polished surfaces of many meteoric irons and when these have been acted on by an acid.

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[1] Farrington, Oliver Cummings, Catalogue of the meteorites of North America, to January 1, 1909: Nat. Acad. Sci., Memoirs, vol XIII, 513 pp., 36 pls., Washington, 1915.

BALD EAGLE METEORITE

A meteorite found on Bald Eagle Mountain near Williamsport was described by Prof. W. G. Owens in a paper read before the Chemical Society of Bucknell University, Lewisburg, Pa. and published in 1892.[1] This was the third meteorite discovered in the State. He wrote as follows:

"The meteorite which I wish to describe at this time was found on or about the 25th of September, 1891, upon the east side of Bald Eagle Mountain, seven miles south of the Park Hotel, Williamsport, Pa. At this point the mountain comes down to the edge of Susquehanna River, a road bed for the Philadelphia-Erie Railway having been cut in the mountain side. Numerous transverse depressions occur in the mountain side and some of these are filled with loose sandstone, varying in size from a few cubic inches to several cubic feet in volume.

"It was in one of these depressions, several hundred feet from the railroad track, that some Italians, while getting out stones for a stone-crusher, found in a bed of loose stones about 2 meters (6⅔ feet) deep, something which resembled a stone in appearance; it was covered with fungus growth as were the stones, but when picked up attracted the laborer's attention on account of its weight. He showed it to the superintendent who tried to break it and failing attempted to cut it with a cold chisel, when it proved to be soft iron. After this it was again lost but soon after found. When, several weeks later, the owner of the crusher, Mr. Geo. S. Matlack, class of 1870, came to the works it was given to him and he, realizing its value, presented it to this University. It weighs 3.3 kilos (7 lbs., 1 oz.). In shape it resembles in general outline a human foot. The flat face, corresponding to the sole, measures 16.6 cm. (6½ inches) long and 8 cm. (3⅛ inches) wide at the broadest place. From the extremity of the heel it projects upward 14 cm. (5½ inches) ending in a point. The surface is covered with a reddish brown rust. This easily scales off in many places, and at several points this covering is so thin that the bright metals shine through. It is pitted quite deeply in some places, and very irregular in outline. On the projection above the heel there is a cavity about 1.5 cm. (⅝ inches) deep entirely burned out and almost opposite a core which has been only partially consumed.

"There are several surfaces which would seem to indicate that the objects which it struck were flat. So even was the surface corresponding to the sole of the foot that when it was cut for etching not more than 2 mm. (2/25 in.) had to be removed to get a surface of 32 sq. cm. (5 sq. in.). At the front there is also a surface of much smaller extent, which is perfectly flat and from it there projects a tip or point. Its specific gravity is 7.06. It is quite soft compared with iron. Most of the surface is covered with a very thin coating of rust. When polished and etched with dilute acid the Widmannstatten lines appeared very distinctly and beautifully. Chemical analysis gave: Fe 91.36; Ni 7.56; Co 0.70; P 0.09; S 0.06; Si, trace=99.77.

"Nothing is known as to the time of its fall, though as it was found covered by several feet of stones which have not moved sensibly since the Susquehanna Valley has been inhabited by white men it could not have been recent. As far as can be learned, this is the only specimen of the fall which has been found."

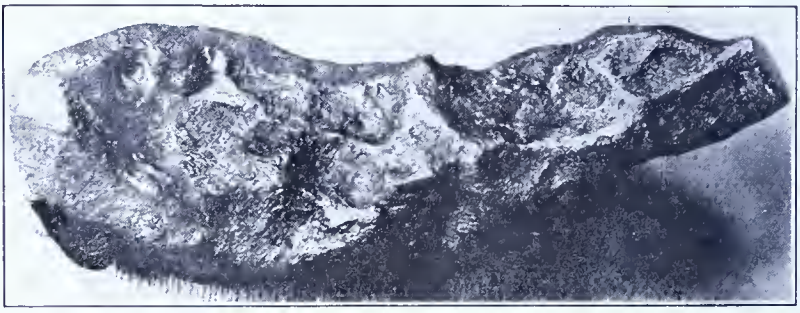
The Bald Eagle iron was loaned by Prof. Owens to H. A. Ward, of Rochester, N. Y. for examination and cutting. Ward published the following details:[2]

"It has seemed to be desirable to add to this description by Professor Owens a view of this most interesting iron. The picture is a half-tone

[1] Owens, Wm. G., A meteorite from Central Pennsylvania: Amer. Jour. Sci., 3d ser. vol. XLIII, pp. 423-4, 1892.

[2] Ward, H. A., Description of four meteorites: Proc. Rochester Acad. Sci., vol. 4, pp. 79-88, December 1902.

2. Bald Eagle meteorite, showing resemblance to human foot, and size compared with a man's hand.



3. Bald Eagle meteorite, showing surface pittings; view is of top of foot, with ankle at right.

After H. A. Ward.

4. Bald Eagle meteorite, polished surface showing Widtmannstattian figures.

After H. A. Ward.

taken from a photograph of the mass before cutting. Its resemblance to a human foot is very striking, despite the many rough notches and depressions which cover the surface. But few of these depressions are well defined pittings, seeming rather to be fractuosities, caused by the violent tearing of the iron from a parent mass, and the sharpness of the angles and crests reduced by the attrition to which the whole mass has been subjected. A portion only of the surface, all the upper part of the ankle, has a well smoothed surface, with a fine granulation akin to a skin or crust. On the back, above the heel, are two sharp depressions, one round and ⅜ of an inch in depth and in diameter, the other, half as deep, a parallelogram ¾ of an inch long and ⅓ inch wide. Both of these have vertical walls, and show clearly as cavities which have once been filled with softer matter, probably troilite nodules, which have since been eroded or decomposed away. On the top of the front part of the foot is

5. Bald Eagle meteorite in hands of the author.

a deep cavity, due to the folds in the iron, which passes nearly through to the sole. The sole itself is very flat, which has allowed a thin slice, ¼ of an inch thick and weighing 300 grammes, to be cut off, of same width from toe to heel, and like thickness throughout, like the sole of a shoe. The polished section is quickly etched by the use of dilute nitric acid, and the Widmannstatten figures produced are both sharp and peculiar. The iron is typically octahedral. The etched surface is composed mainly of short kamacite blades, with an average thickness of about 1 mm. and from 5 to 10 mm. in length. These depart from the ordinary rule defining the usual angular figures by being largely curved or snake-like in form, giving a pattern like that of floss or tangled yarn. Many of these kamacite blades are club-shaped (rounded on both ends) as in the August Co., Va., iron. The patches of plessite are minute, sometimes showing clearly the alternate layers of taenite and kamacite. The taenite plates lying between the kamacite blades are very narrow, but stand out in prominent relief on the etched surface, and are faintly distinguishable by their bronze-yellow color from the tin-white kamacite.

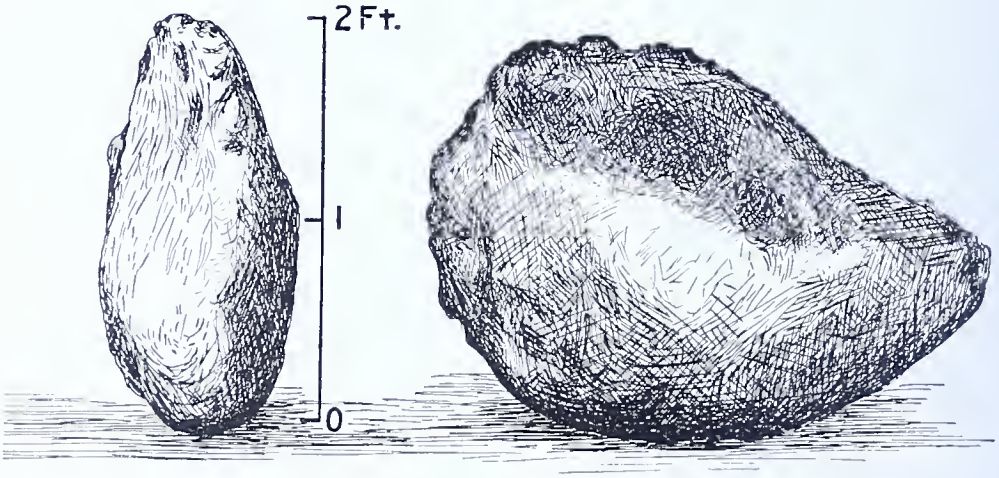
"Two fissures, each about 25 mm. in length and averaging from 1 to 2 mm. in width, cross the sole diagonally, and are filled with troilite. No rounded nodules of this mineral were to be seen in the section made. Several patches of schreibersite, rudely representing cuneiform characters, are scattered throughout the etched surface. These are brighter and with denser surfaces than the troilite, the latter being granular and less lustrous. But the main peculiarity of this iron is the extremely winding, vermiform assembling of the kamacite plates, to which we have already referred. In this respect the Bald Eagle iron is quite unique."

The writer was permitted by Prof. N. F. Davis, curator of the Geological Museum, to examine the Bald Eagle meteorite in May 1931 and to make photographs of it. The resemblance to a small deformed or club foot is striking when viewed from one side (Fig. 2) but less so from the opposite side (Fig. 5).

This meteorite is intact except for the ¼ inch slice removed from the sole by H. A. Ward, as mentioned in his description.

MOUNT JOY METEORITE

The following description[3] is by Mr. Edwin E. Howell of Washington, D. C., who was associated with the Wheeler and Powell



6. Mount Joy meteorite.
Drawing after E. E. Howell.

Surveys in the early days of Federal geological exploration. Later he was proprietor of Howell's Microcosm, a shop in Washington dealing in minerals, fossils, and other natural history specimens, and making relief models of geographic and geologic features.

Professor F. M. Clarke of whom Howell speaks in this paper was for many years chief chemist of the U. S. Geological Survey.

The Mount Joy meteorite, according to G. P. Merrill, resembles the New Baltimore meteorite in its irregularly granular character.

Howell's description follows.

"The accompanying cut gives a good idea of the form of the third largest meteorite found in the United States, and the largest east of the Mississippi River.

[3] Howell, E. E., Description of the Mount Joy Meteorite: Am. Jour. Sci., 3d ser., vol. 44, pp. 415-416, 1892.

"It was found in November, 1887, on or about the 16th of the month, by Jacob Snyder, about a foot below the surface while digging to plant an apple tree near his house, five miles to the southeast of Gettysburg, in the township of Mount Joy, Adams County, Penna. It was supposed by the finder and his friends to indicate the near presence of an iron mine, and considerable prospecting was done to locate it. The meteorite was placed on some timbers in the open air where it remained until the summer of 1891, before it was seen by any one who surmised its true character.

"Professor F. W. Clarke induced Mr. Snyder to send it to the National Museum for inspection, but was finally unable to secure it, as Mr. Snyder was unwilling to part with it for a price, which the museum felt justified in paying. I, therefore purchased it from Mr. Snyder on the 15th of August, 1891. The three largest dimensions of the meteorite are 11, 24, and 33½ inches and it weighed on the museum scales 847 pounds. Professor Clarke had a few ounces taken off for examination; with this exception and the scaling of decomposed crust, from the outside, the mass still remains as it was found.

"Professor Clarke has kindly furnished me with the following analysis, made by Mr. L. G. Eakins in the laboratory of the United States Geological Survey.

"Professor Clarke did not succeed in developing the Widmanstatten figures satisfactorily, and the small amount of nickel shown by the analysis would indicate a poor etching iron; when larger surfaces are available, we shall doubtless obtain better results.

Fe	93.80
Ni	4.81
Co	0.51
Cu	0.005
P	0.19
S	0.01
	99.325

"No idea can be formed of the length of time the meteorite had lain in the ground and very little of the amount of surface decomposition, it has undergone—sufficient, however, to remove all the finer pittings, leaving a comparatively smooth surface.

"Having been much interested in Mr. Davison's examination of the magnetic properties of the Welland meteorite, and thinking that this line of investigation in other meteorites might lead to interesting results, I requested Mr. Marcus Baker of the U. S. Geological Survey, to make an examination of the meteorite, which he kindly consented to do.

"The result of this examination is to show that the meteorite, as a whole, acts as a mass of soft iron, gaining polarity under the inductive action of the earth. The lower portion on the north side became a north-seeking pole, while the upper part became a south-seeking pole; a pretty distinct neutral line was shown, inclined to the horizon at an angle (20°-25°) which is approximately the complement of the local inclination of the dipping needle. This induced polarity shifted with each change in the position of the whole mass, and in general this shifting of the poles took place promptly though not always at once. Mr Baker also states that his observations suggested the probable existence of an unequal distribution of permanent magnetism, but this matter requires further investigation."

Brezina[4] observed as follows regarding the Mount Joy meteorite:

"A lumpy grain of the size of a nut which fell out during the cutting shows the imprint of the neighboring grains. Upon the section surface are to be seen bent Neumann lines with somewhat brighter yellow-colored porous crystals of troilite."

[4] Brezina. Wiener Sammlung, p. 293, 1895.

After acquisition of the principal part of the mass by the Vienna Museum the structure was studied by Berwerth[5] with the following results:

"The analysis by Eakins led Linck to class Mount Joy as a hexahedrite, and when later Brezina, on a piece broken from the surface, observed Neumann lines the meteorite was classed as a breccia-like hexahedrite. For the purpose of investigation and material for exchange the mass at the Vienna Museum was sawed in two parts in the direction of its principal section, and the smaller part cut into corresponding smaller plates parallel with this section. The faces obtained were so large and their character so remarkable that a complete investigation of the iron is in preparation; here the only endeavor will be to correct the error regarding its structure which has crept into literature. The preparation of the faces for exhibition showed without question that Mount Joy belongs to the octahedral irons, and by its very coarse structure should be placed among the last of the octahedral irons classed as having coarsest lamellae. The general structure of Mount Joy is that of a coarse-grained mass, the coarse grains of which are intergrown and so elongated with a certain regularity in one direction that the grains have a relatively short rodlike shape. From this shape and the position of the grains arises an appearance of Widmanstatten figures that is plain to the eye on a large section. The fine crystalline structure of the single grains makes the figures more distinct, since the grains show a similar course of Neumann lines, luster, and sheen. Contrary to the usual structure of octahedral irons with more compact band systems, Mount Joy shows by reason of the more granular than lamellar formation a disconnected network of figures. A regular inclusion of fine rhabdite is common to the grains. As regards the appearance of the etched surface the grains show two characters. Along the section the course of the Neumann lines is shown plainly. In another part of the mass the Neumann lines show only weakly. This disguised appearance of the lines comes from the fact that the mass of the grains has a composition of two fields, one of which is depressed and the other appears swollen on the etched surface. This gives a spongy or shagreened appearance. In certain sections the etching of the fields is oriented. The two fields show parallel striae and resemble the perthitic structure seen in twin feldspars. Of other components which occur in the meteorite, troilite is present only in relatively small quantity in scattered nodules of medium size. Single nodules contain white and lustrous crystalline inclusions. The troilite is regularly surrounded by a coating of schreibersite. Schreibersite appears in larger skeleton-like crystals in the iron grains, also inclosing the troilite and interspersed between the grains. Where the spaces between the grains are open wide and are cleft a dark oxidation product of iron taking a good polish accompanies the schreibersite. These fillings are commonly regarded graphitic. Graphite seems, however, to be everywhere lacking. Where these oxidized interspersions are extensive there may also be seen an earthy yellow silicate. To the above may be added the statement that the manner of the octahedral structure of Mount Joy, showing its composition of great crystalloids, requires a change in the present classification of iron meteorites. Probably a revision of the so-called brecci-like hexahedrites will be required and its members put into the octahedrite division. * * * Further, it is indicated that all iron meteorites possess an octahedral structure and that the meteorites of hexahedral structure which have fallen to our earth are simply fragments of octahedral irons of very coarse structure."

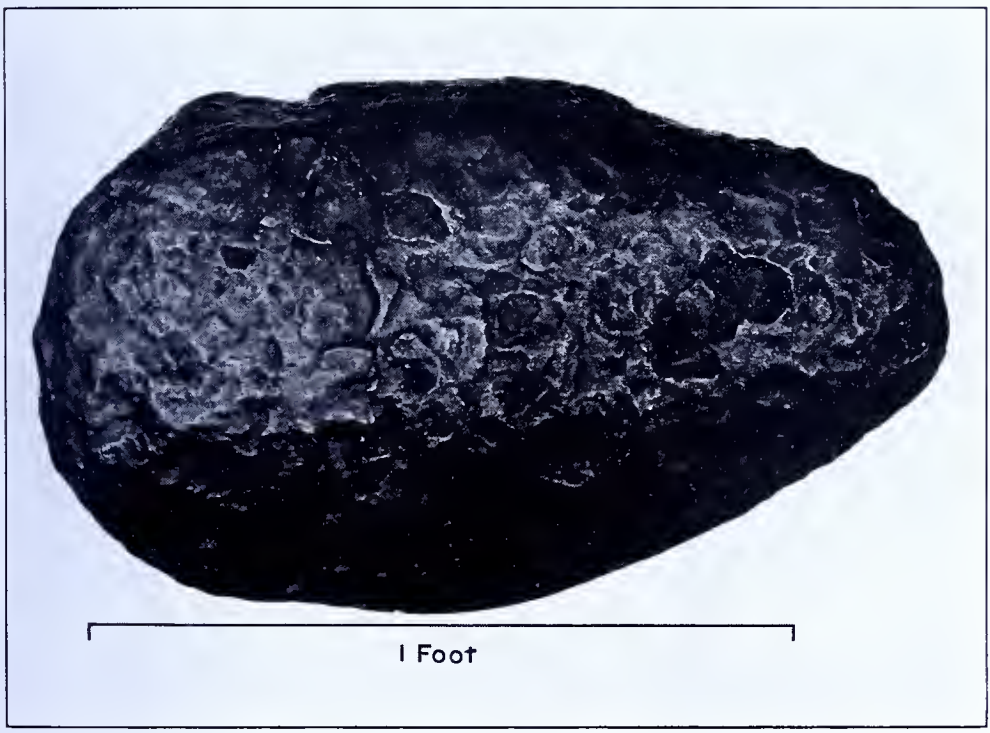
As Mr. E. E. Howell, the original purchaser, was a dealer in minerals, it is presumed that this meteorite was broken up and sold. The Mineralogical Museum at Harvard University has a single piece weighing 568 grams (about 20 pounds), and E. R. Barnsley, of Newtown, Pa., tells me that he saw a piece in the

[5] Berwerth. Ann. K. K. Nathurhist. Hofmus, Wien, Bd. 12 (Not.), pp. 56-57, 1897.

Mineralogische-Geologische Stattsinstitut, Hamburg, Germany, weighing 248 grams. The Academy of Natural Sciences of Philadelphia has an etched slice of this meteorite.

NEW BALTIMORE METEORITE

In September 1922 the Pennsylvania Geological Survey received a 2-ounce mineral specimen for identification from Mr. W. C. Keyser, Schellsburg, Bedford County. It was at once recognized by Dr. George H. Ashley, State Geologist, as meteoric iron and on October 12, 1922 the writer called at Mr. Keyser's home and saw a lump of meteoric iron 23 pounds in weight from which the small piece



7. Model of New Baltimore meteorite in Pennsylvania State Museum at Harrisburg.

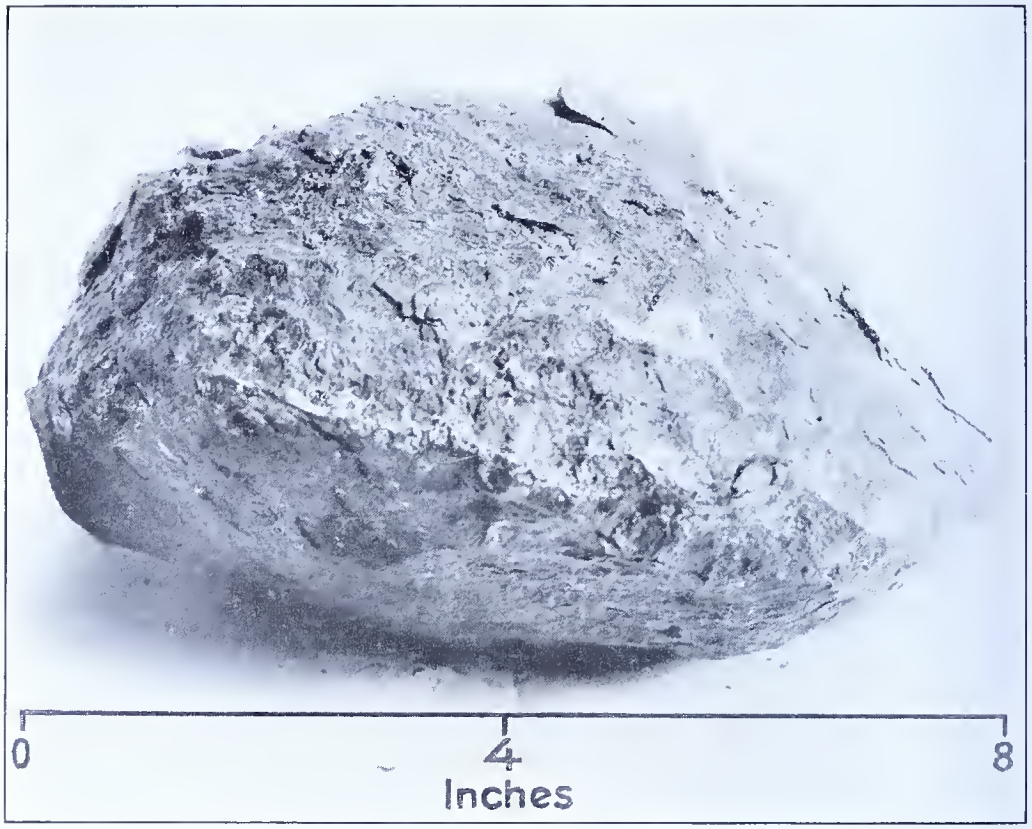
Made by Wm. Durborrow from measurements and photograph by the writer. Photo by Boyd Rothrock.

had been detached. This lump was said to be one-half of the original find, the other half being on the farm where found. I accompanied Mr. Keyser to this farm on the crest of Allegheny Mountain 2½ miles south of the Lincoln Highway and 3 miles northwest of New Baltimore, Somerset County, and we brought the other half back to Schellsburg.

According to Mr. Keyser, in the summer of 1922 Mr. Jefferson Long, while plowing in a corn field, unearthed a cobble so heavy that it attracted his attention. It was about the size and shape of a small ham but weighed nearly 40 pounds. Mr. Long broke it in two pieces with a sledge, a feat made possible by the coarsely

granular character of the iron. He took part of it to Mr. Keyser as a curiosity and, as related above, it thus came to public notice.

I succeeded in nearly fitting the parts together and concluded that the iron as originally found measured about 14¾ inches long and 8 inches at its greatest width. The circumference on the long axis was about 29 inches and crossways about 21½ inches. The mass was elliptical in cross section with a greatest thickness of 3½ inches. One of the main pieces approximated the half of an



8. End view of New Baltimore meteorite, showing one side domed more than the other, and shallow pitting and scaling.

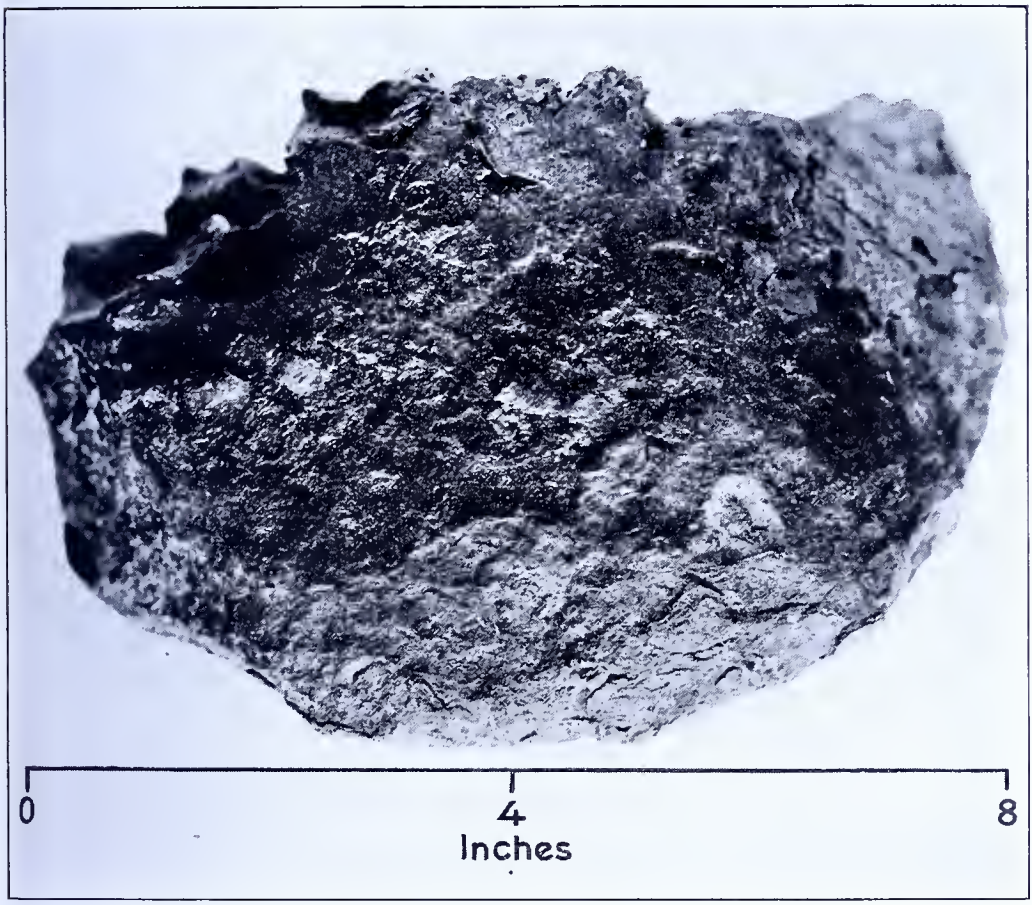
Photo by Boyd Rothrock.

ellipse in outline, measured 7 inches in diameter, 17 inches in circumference, and 3 inches thick. The other piece was roughly triangular, approximately 6½ by 8 inches across and 3½ inches thick.

The exterior surface of the original mass was considerably oxidized and slightly scaly. A light tan colored shell concealed a rusty red inner skin. Freshly fractured surfaces were iron black. A coarsely granular texture was recognizable in the broken faces. The individual granules, ranging up to 1 inch in size, have irregular shapes, with sharp, narrow ridges outlining slightly concave faces. These granules are closely interlocked. Only by

repeated heavy blows with a sledge was part of the meteorite broken off. The irregular granules clung tenaceously but tended to break down to coarse, rough fragments.

The field in which this meteorite was found is within a few rods of the crest of Allegheny Mountain and underlain by Pottsville sandstone. A search over this field and adjacent pastures did not disclose other pieces of meteoric iron, and inquiry of residents in the neighborhood, which is sparsely settled, was fruitless of recollections of a conspicuous falling star.



6. One-half of New Baltimore meteorite, showing rounded larger end and jagged break.

Photo by Boyd Rothrock.

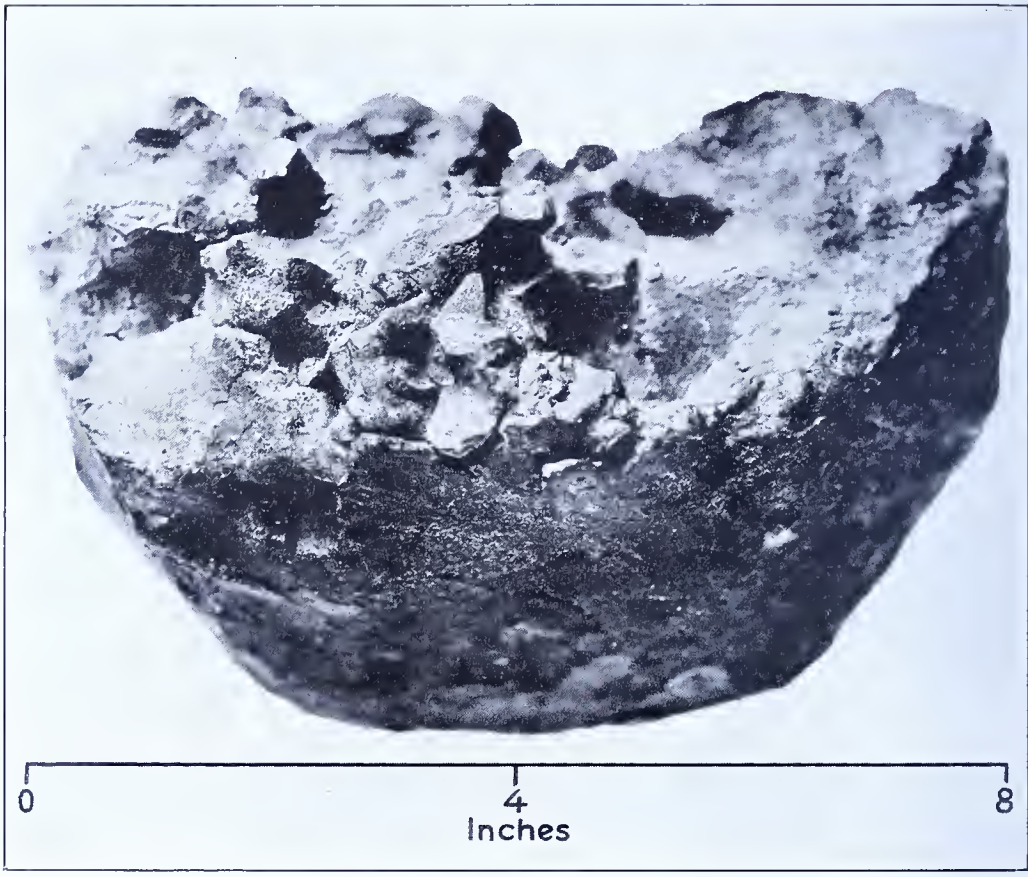
Mr. Keyser kindly permitted the writer to send a few fragments of the meteorite to G. P. Merrill, curator of geology, U. S. National Museum, for examination and analysis.

The first published notice of the New Baltimore meteorite was by Merrill[6]. In accordance with the usual custom of designating by a near by geographic feature, Merrill named it the New Baltimore and wrote as follows:

"A single glance at the iron suggested at once the possibility of its being a portion of the Mount Joy, Adams County, fall, and also explained how the mass could become so readily broken into fragments. Like the Mount

[6] Merrill, G. P., A newly found iron meteorite from Somerset County, Pennsylvania: Am. Jour. Sci., vol. V., pp. 175-176, February 1923.

Joy iron, it is an irregularly granular mass, the individual granules of which vary in size up to 40 mm. or more. These, while closely interlocking in the fresh iron, on weathering separate and fall away as a coarse metallic gravel. Those who have had to do with the last named iron will recall a similar characteristic which made it almost impossible to preserve it intact. When polished and etched the individual granules are essentially structureless, a feature of the Mount Joy iron that caused it to be first classed as a brecciated hexahedrite (Hb), and it was not until a large surface was exposed to etching that its true coarsely octahedral nature was disclosed.



10. One-half of New Baltimore meteorite, showing coarsely granular character of break.

Photo by Boyd Rothrock.

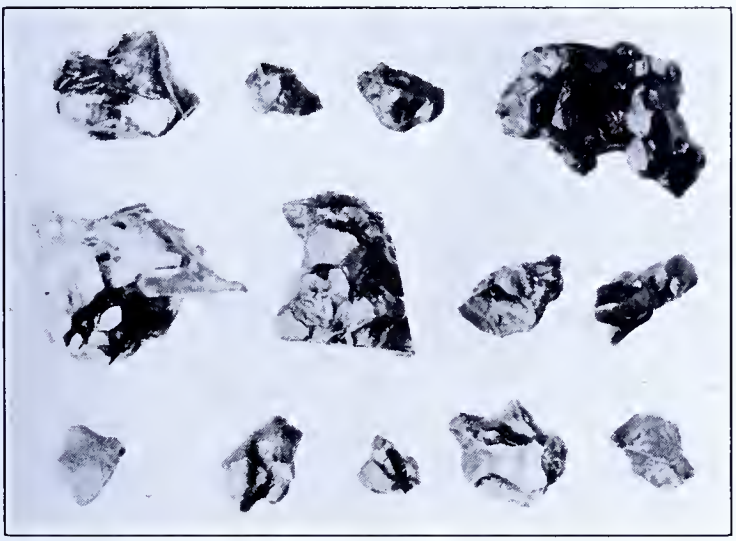
"A granule of 100 grams weight was submitted to Dr. J. E. Whitfield for analysis with results as in column I below. In column II is given the composition of the Mount Joy iron as determined by Mr. Wirt Tassin in 1892 (This Jur., vol. 44, p. 415).

	I	II
Iron	93.256	93.80
Nickel	6.420	4.81
Cobalt	0.325	0.51
Copper	none	0.005
Phosphorus	0.037	0.19
Sulphur	none	0.01
Manganese	none	
Silicon	0.010	
Carbon	0.015	
Total	100.063	99.325

"The only marked difference in these results, it will be noted, is in the percentage amount of nickel. Just how much weight is to be attached to this the writer is not at present prepared to state. Further analyses of the Mount Joy iron are needed to settle the point. The absence of sulphur, manganese and copper, and low content of phosphorus are features worthy of note.

"The distance between Allegheny Mountain in Somerset County and Mount Joy in Adams County, as measured in a straight line on the map, would be approximately 90 miles. On the assumption that the meteorite was traveling in either an easterly or westerly direction, this distance is not considered too great for them to be relegated to one and the same fall, as above suggested, though I do not know that we have any definite record upon which to base such an opinion. * * *"

Subsequent to the preliminary description further laboratory work disclosed several noteworthy features. These were described by Merrill[7] as follows:



11. Granules broken from interior of New Baltimore meteorite.

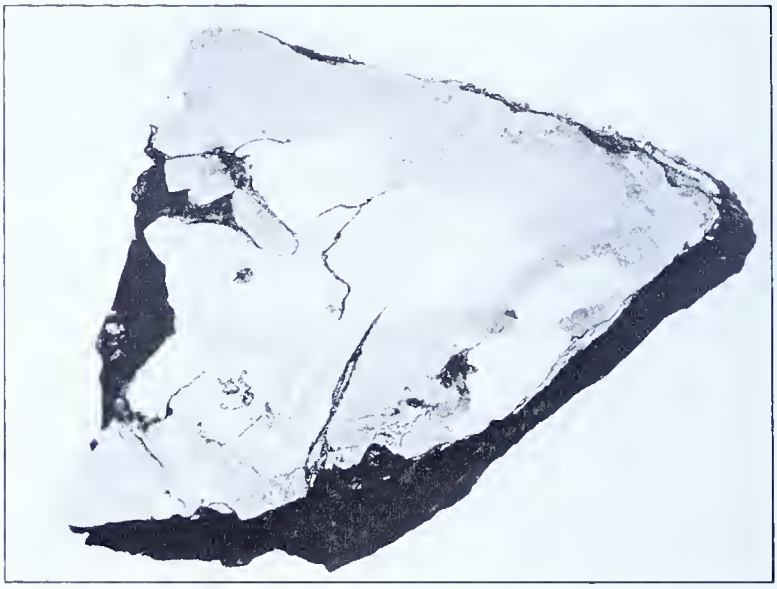
Photo by G. P. Merrill.

"As stated in the first paper, the iron, like that of Mount Joy (also Ainsworth), has a coarse irregularly granular structure, the individual granules varying in sizes up to 40 or more millimeters. These while closely interlocking show a tendency to separate and on weathering to fall away to a coarse metallic gravel. Even where there are no distinct evidences of weathering—as oxidation—the granules by hammering can be separated, breaking out in peculiarly irregular forms with smooth, black, somewhat lustrous surfaces. A considerable number of these were polished and etched on various faces and invariably showed the characteristic hexahedral structure and Neumann lines. It was surmised, however, that larger polished surfaces might show the iron to be a very coarse octahedrite as was the case with the Mount Joy iron and hence the sample was cut and polished in a way to give the roughly triangular surface 11.5 cm. x 8.5 cm. shown in the plate. Fig. 12. The structure as thus brought out is wholly unlike anything I have before met with or seen described, the coarsely granular portion on either side being bordered by somewhat undulating kamacite plates so arranged as to suggest an octahedral structure but with no intervening taenite or plessite fields. The large kamacite granules are sharply differentiated and, as stated, can often be broken

[7] Merrill, G. P., The New Baltimore, Somerset County, Pennsylvania meteoric iron—Supplemental note: Am. Jour. Sci., vol. VI., pp. 262-264, September, 1923.

entirely free from one another but seem less sharply differential, more closely welded as it were, to the octahedral portions. With considerable difficulty a piece of the iron was cleaved off and after polishing and etching on all sides to insure its uniform structure, was submitted to Dr. Whitfield for partial analysis. The result is given in column I below, while in column II is that of one of the hexahedrite nodules as given in my first paper. The two portions are then chemically identical and typical of kamacite.

	I	II
Fe	93.02	93.256
Ni	6.38	6.42
Co	0.43	0.325
P	not. det.	0.037
Si	"	0.01
C	"	0.015
Total	99.83	100.063



12. Polished section of New Baltimore meteorite showing granular character and supposed fault as a sharp curved line from lower left to upper right.

Photo by G. P. Merrill.

"The structure, so far as my experience goes, is quite unique and but for the analyses would suggest an admixture of two different irons rather than local enlargements of kamacite bands in a very irregular coarse octahedrite as seems probably the case. In this respect it differs from the Mount Joy and Ainsworth irons with which I have compared it.

"A second and equally interesting feature shown by the section is a small fault with a throw of about one centimeter which is visible in the plate as a sharp curved line extending from the lower left, upward to the right margin. At the left this seems to have been slightly enlarged by oxidation but for the remainder of the distance is as sharp as though scratched with a diamond. The amount of displacement is most plainly evident in the large kamacite granule in the lower right center and less distinctly in other portions. It is to be noted that though the iron is soft and malleable at ordinary temperature there is not the slightest indication of any drag between the walls of the fault. To account for this, one seems justified in concluding that the fracturing, or faulting, was the result of some sudden shock, like a collision, occurring when the iron was rendered brittle by intense cold.

"It is difficult to classify this iron by any of the prevailing systems, but I have placed it provisionally in Berwerth's kamacite octahedrites group KO. This is the fifth meteorite reported from Pennsylvania; all are iron and none of them seen to fall."

The main mass of the New Baltimore meteorite was bought by the Mineralogical Museum of Harvard University, through Dr. G. P. Merrill of the U. S. National Museum. According to Prof. Charles Palache, curator, it was received at the Mineralogical Museum in two pieces, one weighing 23 pounds (10.4 kilograms) and the other 17 pounds, 10 ounces. The larger piece is still in that museum. The smaller piece was sent to the National Museum in 1925 and cut into several slices. One slice weighing 1½ kilograms (3.3 lbs.) is in the U. S. National Museum, Washington, D. C.; another of the same weight is in Field Columbian Museum, Chicago, and a third with a weight of 2.87 kilograms is in the Mineralogical Museum at Cambridge, Mass.

The National Museum also has the fragments sent by the Pennsylvania Geological Survey in 1922, except one weighing 55 grams which it sent to the British Museum.

The State Museum at Harrisburg has some small fragments, and also has a model of this meteorite which was constructed in the museum laboratory by Mr. William Durborrow from measurements, sketches, and photographs by the writer; and by Boyd Rothrock, curator of the State Museum.

I have a lump from the interior that came loose during the original breaking. It is 1¼ inches long, ¾ inch wide, and ½ inch thick, irregular in shape, with conchoidal faces. One face has been ground flat. It weighs 32.4 grams, or a little over one ounce.

PITTSBURGH METEORITE

The first notice of a meteorite found in Pennsylvania was given by Prof. B. Silliman, Jr. at the fourth meeting of the American Association for the Advancement of Science, held at New Haven, Conn., August 1850. The minutes of the meeting contain the following statement:[8]

"The second mass of iron noticed by Prof. Silliman was found in the State of Pennsylvania, near the city of Pittsburgh. The attention of Prof. Silliman was called to this mass by Mr. George Weyman, a student in the Analytical Laboratory of Yale College, and through him all the details of its history have been obtained, which can now be hoped for, from Mr. John H. Bailey, of Pittsburgh. Prof. Silliman then read extracts from a letter from Mr. Bailey, dated June, 1850, from which it appears that this mass of meteoric iron was found in a field upon Miller's Run, in Allegheny County, Pennsylvania, near Pittsburgh. A farmer was ploughing in the field, where, seeing a snake, he seized a stone, as he supposed, to destroy the animal, but, finding it remarkably heavy, he was attracted, after accomplishing his purpose, to examine the body which possessed such a remarkable weight. It was carried to Pittsburgh, where it was found to be very malleable, and unfortunately wrought into a bar, which has since been lost sight of. The mass was of an orvidal (ovoidal) figure, almost six or seven inches in diameter, and weighed nearly 292 pounds. It is greatly to be

[8] Silliman, B. Jr., Notice of two American meteoric irons: Proc. Am. Assn. Ad. Sci., vol. 4, p. 36-38, 1851.

regretted that only a very small portion of this large mass has been preserved. A qualitative examination of it has shown that it is rich in nickel, and possesses only a very inconsiderable portion of insoluble acids."

If this iron was comparatively symmetrical, a spheriod measuring 6 or 7 inches, the volume was approximately 130 cubic inches and the weight may have been 29.2 pounds, not 292 pounds as reported. Miller's Run is a branch of Chartiers Creek on the southwest boundary of Allegheny County, and about 8 miles from Pittsburgh.

According to Shepard[9] the specific gravity was 7.380.

Genth repeated Silliman's description in his Mineralogy of Pennsylvania, and in the appendix of that book gave the following additional information:[10]

"The small portion of the meteoric iron from Pittsburgh, referred to in my report B, of 1875, has been preserved in the Yale College cabinet. Mr. Edward S. Dana, the curator of this collection, presented me with a small fragment, which I submitted to a fuller investigation.

"Its specific gravity, which Shepard gave as 7.380, was found to be 7.741, the average of three closely corresponding determinations by Dr. Koenig, Dr. Headden, and myself. After polishing and etching with dilute nitric acid, it presents Widmannstatten's figures which are produced by inclosed schreibersite. In the section which has been made, it happens that most of the exceedingly minute schreibersite crystals are cut across, and are seen as small dots on a frosted surface; some appear as minute needles, arranged in parallel lines, like the trees in an orchard. A few elongated patches of a whiter iron-nickel alloy are also visible.

"The analysis of a somewhat oxidized piece, gave the following composition.

Iron	92.809
Copper	0.034
Cobalt	0.395
Nickel	4.665
Manganese	0.141
Sulphur	0.037
Phosphorus	0.251
Total	98.332

0.251 per cent of phosphorus are equal to about 1.8 per cent of schreibersite."

A 99-gram piece of the Pittsburgh meteorite acquired by Gottingen University was studied by E. Cohen,[11] who described it as follows:

"It was a very irregular piece with ragged edges, and had evidently been cut with a chisel from the mass and from the peripheral portion of the latter, since there seemed to be small flat parts of the border of the original surface of the meteorite. By cutting, a surface of 4 sq. cm. was obtained.

"Etching proved that Millers Run is actually, as Reichenbach stated, an octahedrite. The coarse lamellae are for the most part of an irregular lumpy form, sometimes elongated and regularly bounded. Some of the bands lie immediately upon one another, others are divided by a minute cleft; between many of them, however, a distinct taenite band is found, which at the point where several lamellae cluster together broadens out into somewhat large, triangular portions. That no schreibersite is present

[9] Shepard, C. U., on meteorites: Amer. Jour. Sci., 2d ser., vol. 11, p. 40, 1851.

[10] Genth, F. A., Mineralogy of Pennsylvania: Penn. Second Geol. Surv., Report B, p. 207-8, 1875.

[11] Cohen, E., Mitth. Naturwiss. Verein. Neu-Vorp. und Rugen, Bd. 35, 4 pp., 1903.

is easily proven by testing the ductility with a fine needle. As usual in coarse octahedrites, plessite is very inconspicuous; the tiny little portions are rich in combs.

"The kamacite bands act differently. At some distance from the original surface of the mass it is coarse-grained, shows distinct hatching marks and numerous uniformly distributed etching pits; the more granular it is the less prominent are the hatchings, while the etching pits remain about the same in amount. In a few bands numerous small, brightly glistening rods are found, which appear to be schreibersite.

"An outer zone of from 1 to nearly 1.5 cm. in breadth, whose border runs in a wavy or serrated outline, but which was partially cut off and does not coincide with the boundaries of the lamellae, appears much altered. It is duller and darker than the interior of the meteorite, and the kamacite is spotted, while very irregular particles as much as 0.5 mm. in size are distinctly differentiated from one another by a lively oriented luster, though not sharply separated. The coarse granulation of the bands is obscured or entirely disappears.

"This is undoubtedly a zone of alteration; whether it is original or not, or whether the piece under investigation was partially heated in the working up of the main mass and then cut off, must remain uncertain. The latter may be more probable, since in the case of so large a mass (132.5 kg.) a considerably narrower zone of alteration is usually met with, unless, indeed, this should be a tongue-like projection.

"The only accessory material observed was a few small particles of schreibersite.

"The analysis of Hildebrand gives the following figures:

Fe	93.38
Ni	5.89
Co	1.24
Cu	0.05
Mn	0.00
Cr	0.02
S	0.07
P	0.15
Chromite	0.07
Total	100.87

This gives the following mineralogical composition:

Nickel iron	98.78
Schreibersite	0.96
Troilite	0.14
Daubreelite	0.05
Chromite	0.07
Total	100.00"

The above description by Cohen is copied from Farrington.[12]

The Mineralogical Museum, Harvard University, has a piece of this meteorite, weighing 1,332 grams (about 3 lbs.).

SHREWSBURY METEORITE

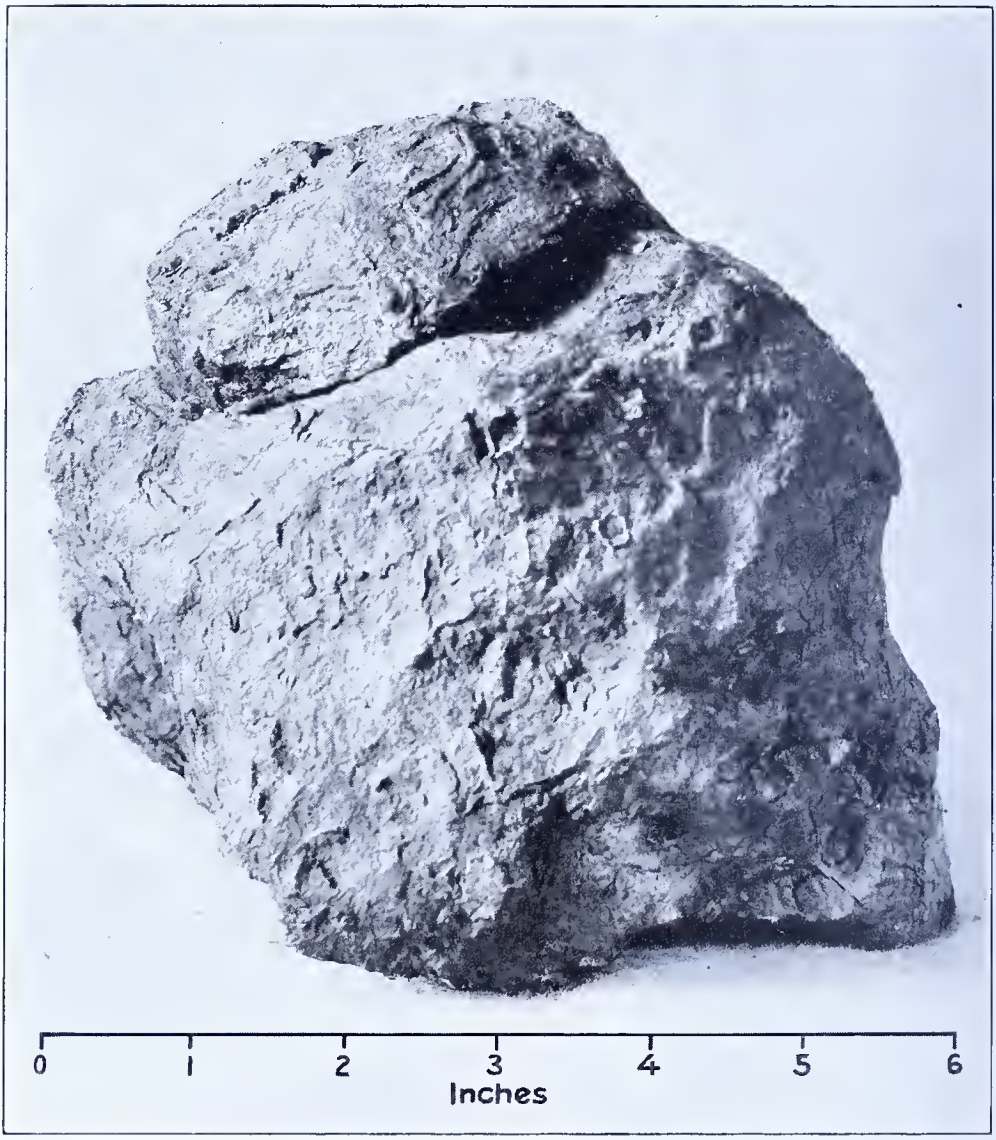
The fourth Pennsylvania meteorite was described by O. C. Farrington[13] as follows:

"To the iron meteorites known from Pennsylvania, Bald Eagle, Pittsburgh, and Mount Joy, a fourth is now added. This last cosmic accession was found in 1907 on a farm about seven miles north of Shrewsbury, York

[12] Farrington, Oliver Cummings, Catalogue of the meteorites of North America, to January 1, 1909: Nat. Acad. Sci. Memoirs, vol. XIII, p. 354, 1915.

[13] Farrington, O. C., A new Pennsylvania meteorite: Am. Jour. Sci. vol. XXIX, pp. 350-352, April 1910.

County, Pennsylvania. It was discovered by being struck by a plow while plowing and attracted attention on account of its unusual weight. As the region is one in which more or less brown limonitic iron ore occurs, the meteorite was supposed by its finder to be an unusually heavy specimen of such ore and as such was shown to Mr. F. Justice Grugan of Philadelphia when in the vicinity in June, 1909. Mr. Grugan, in whose possession the meteorite now is and to whom the writer is indebted for the history here given, at once recognized the meteoric nature of the mass, and took steps

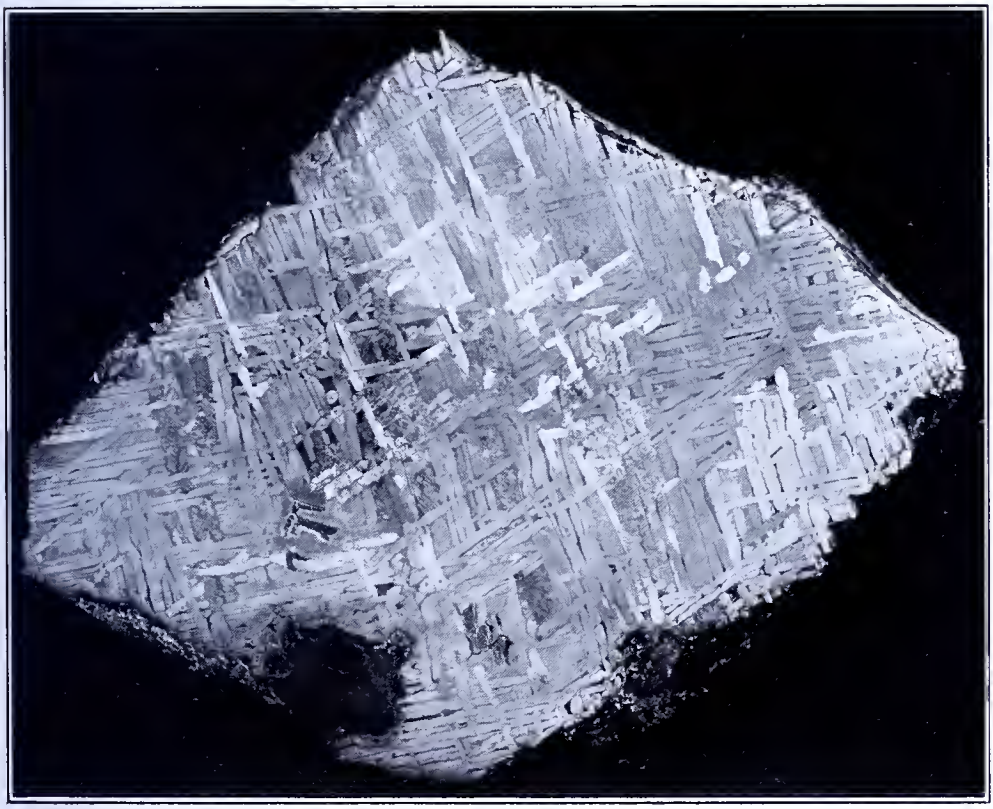


13. Shrewsbury meteorite, external appearance; weight 24 pounds.
Photograph published by courtesy of Field Museum of Natural History, Chicago.

for its preservation. He also instituted a search for any associated specimens that might be in the vicinity. In this he was successful to the extent of finding several fragments that had been distributed as curiosities, but no important additional individuals were found. The smaller pieces obtained were reported to have been found about three-quarters of a mile northwest of the main mass. If this distribution was a natural one, a southeasterly course of the meteor is indicated. The fragments and mass placed in the hands of the writer for examination had evidently all belonged to a single

individual. The main mass as received weighed 24 pounds and the fragments 3 pounds more, giving a total weight to the meteorite as now known of 27 pounds (12.2 kgs.). The form of the meteorite as restored by adding the fragments is roughly rhombohedral, with dimensions of about 6 inches (15 cm.) on a side. At the same time there is much rounding of the solid angles and there are many depressions and irregularities which make the above characterization of the form only an approximate one.

"Owing partly to decomposition from lying in the soil and partly probably in rough handling, the appearance of the original surface of the meteorite remains over less than half the mass. Where seen it shows the usual rounded and smooth exterior of iron meteorites with broad, shallow pits, the broadest being about 3 inches (7 cm.) in diameter. There has been considerable alteration of this surface through weathering, so that its substance has become more or less friable and limonitic in character. This



14. Shrewsbury meteorite, etched section.
Photograph published by courtesy of Field Museum of Natural History, Chicago.

alteration appears to extend in places to a depth of about half an inch (1 cm.). Where the original surface is not present the meteorite shows a jagged fractured appearance and exhibits typical octahedral structure. It is probable that over such portions the original surface has disintegrated and fallen away, though the appearance at one point would indicate a rounding of the mass in the air like that shown by one of the Glorieta Mountain (N. M.) individuals.

"On account of oxidation the mass as a whole presents a generally rusty brown color with spots of a green incrustation, due doubtless to the formation of some nickel salt. The undecomposed nickel-iron is easily cut by a file, but is not malleable owing to a well-developed laminated structure. Under the hammer, therefore, it is inclined to crumble. Plates of bronze-yellow, flexible, magnetic taenite can be easily separated both from the decomposed and undecomposed nickel-iron.

"Analysis of the meteorite by Dickman and Mackenzie of Chicago gave the following result:

Fe	90.84
Ni	8.80
Co	tr.
S	0.01
P	0.29
Total	99.94

"Sections of the meteorite show a firm, homogeneous interior with little or no disintegration. Broad, straight lamellae almost entirely prevail. These lamellae average a little over one millimeter in width, thus placing the meteorite in the group of medium octahedrites. For the most part the lamellae show simple, broad bands of kamacite, but some of these are seen on closer examination to be made up of smaller lamellae grouped together. The kamacite shows considerable hatching, generally in a single direction. Where fields occur they appear to be mainly of two kinds: 1, those made up of numbers of minute taenite foliae with parallel arrangement and parallel to the adjoining bands, and 2, those made up of kamacite grains bordered by taenite and showing a more or less divergent arrangement. Accessory constituents are comparatively abundant and scattered irregularly over the section though somewhat more numerous toward the periphery. They include troilite and schreibersite, the troilite occurring in spheroidal and the schreibersite in hieroglyphic forms. The troilite is characterized by a bronze-yellow color and dull luster, the schreibersite by a tin-white color and shining luster. One troilite nodule in the section especially studied by the writer is more nearly circular in form, 2 cm. in diameter and has an irregular border of schreibersite. In other places the troilite has a more nearly vein-like distribution and is more or less mixed with schreibersite. Hieroglyphic schreibersite occurs at several points, usually in groups of three. The grains are from 4 to 8 millimeters in length. Swathing kamacite from 2 to 4 millimeters in width surrounds the schreibersite inclusions, but there is none about the troilite."

Mr. Grugan, who first recognized its character and was for a time possessor of this meteorite, appreciated the value of such material to science and kindly allowed it to be sliced into museum specimens that it might be widely distributed among museums and students of meteorites. The National Museum, Washington, D. C., the Academy of Natural Sciences, Philadelphia, Pa., and the Mineralogical Museum at Harvard University have slices. The latter weighs 508 grains, or 1 pound, 2 ounces.

UNCONFIRMED FALLS

No one knows when any of the five meteorites here recorded fell to the earth. There is record, however, of a meteor which passed over Somerset County August 4, 1921 and is supposed to have struck near Murdock. C. L. Weigle, an engineer of the Pennsylvania Water and Power Resources Board, says he was at Listie, 7 miles from Murdock on that date, heard the explosion and felt a vibration. Mr. Weigle kindly furnished a copy of the newspaper account of this event.

METEOR FELL WITH HEAVY THUD.*

Milford Township farmer knocked from chair and tableware shattered by concussion.

"George Countryman, who occupies the old General Coffroth farm, opposite Murdock station, on the Somerset & Cambria Railroad, 4 miles south of Somerset, had the shock of his life about 8:30 o'clock last Thursday night when a large meteor flashed through the air and struck the ground a few rods from his house. A terrific explosion followed. Mr. Countryman who was sitting in a rocking chair on the front porch of his residence, was thrown from his chair to the porch floor by the concussion and for a time he believed that a bombing squadron of airplanes was making a target of his place. The explosion was heard by families living within a range of 2 or 3 miles of the Countryman home, but thinking that an unusually large charge of dynamite had been exploded in the stone quarries back of Murdock, they forgot all about it until they were later informed of the fate of the celestial visitor.

"Dishes and window glass were broken by the explosion in several residences near Murdock. Early Friday morning Mr. Countryman went to the spot which he knew to be the scene of the explosion but the only evidence he could find was a dent about 2 feet deep in the earth and a few particles of an unknown metal. The dent was conical in shape and the area covered was 4 feet. The vegetation surrounding the rim of the crater was scorched and burnt. Frank E. Jordan, Professor of Astronomy at the Pittsburgh University was in Somerset for a week-end visit at the home of Mr. and Mrs. C. F. Roy and as soon as he learned of the falling meteor he visited the Countryman farm, accompanied by Mr. Roy, and made close observations. He was successful in gathering a number of fragments which enabled him to identify its character."

In a letter dated January 11, 1932, Mr. George L. Countryman, then living in Somerset, informed me that he sold the Coffroth farm three years ago and a box containing fragments of the meteorite was lost in moving.

In reply to my request for confirmation of the story, Prof. Frank C. Jordan, director, Allegheny Observatory, University of Pittsburgh wrote January 16, 1932: "I know of the fall only from those who claim they saw the flash and heard the sound. I saw where it was supposed to have made a hole in the ground, but in the hole there was no sign of any foreign substance. Around it were some fragments of rock, but whether they were of mete-

*Somerset Herald, August 10, 1921.

oric origin or not, I was not absolutely certain. The story of the meteorite was plausible, but I was not fully convinced about it."

The following item is quoted from Science, p. 40, Jan. 13, 1928:

On November 12, 1927, newspapers in the Eastern States carried a New York World News Service statement that on November 11 a meteor, accompanied by a bolt of lightning, struck at Fairdale, near Montrose, Susquehanna County, Pennsylvania. The lightning set fire to a building and the meteor made holes 12 to 14 inches in diameter in the concrete highway. Of particular interest was the statement that around these holes in the highway was discovered a strange substance that very much resembled bituminous coal.

The Pennsylvania Geological Survey made inquiry through different channels and received a most satisfactory reply and explanation from H. R. Moffitt, district engineer, Pennsylvania Department of Highways, at Scranton. He writes:

> Lightning struck a barn to which an aerial was attached, running thence to the house and down the ground wire and was apparently conducted through the water that covered the ground at this location, to the pavement. The pavement in several places was shattered along the edge about 10 inches in from the edge and about three inches deep, where the concrete was broken out exposing the reinforcing. The total breaks can be repaired with about one gallon of tar and one hundred pounds of stone. The asphalt crack filler, in several places, was blown out and burned and the material resembled soft coal, which I believe gave rise to the newspaper account of the story.

This note is published so that future catalogs of meteorites will not include this one from Fairdale, Pennsylvania.

R. W. Stone

Harrisburg, Pa.